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Research Treatment Studies for Cleanable Waste Water for Cleaning Pipes

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Abstract

Currently, many methods of treating waste water are known using various lubricating coolant compositions, but there is no universal treatment method. The most suitable ways of reducing the harmful impact of waste water in the metallurgical industry on the water environment are 1) the local treatment of waste water of various compositions, 2) the removal or reduction of the total amount of waste treatment liquid emissions as a result of their regeneration, and 3) reuse of treated waste water in closed water circulation systems and technical water supply to enterprises. During production of bimetallic finned tubes by cold deformation method, alkaline cleaning solutions are used to clean the surface from lubricating-cooling liquid. As a result, there is a need to dispose of spent liquids. The spent detergent solution is a three-phase emulsion. The upper layer is oil-oil products, medium liquid with increased PH index, and aluminates precipitate. A spent emulsion, i.e. an end-of-life emulsion that has lost its functional and operational properties, needs to be decomposed and disposed of.

Keywords: finned bimetallic tube, air cooler, lubricating coolant, oil – emulsion.

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In the production of bimetallic finned tubes for air cooling apparatuses (ACA) by the method of cold deformation, alkaline detergent solutions are used to clean the surface of the cutting fluid (CF). After a certain period, the solution is saturated with CF and machined products. The waste solution belongs to the substances of the second hazard class, as a result of this there is a need for disposal of the spent solution. Spent cleaning solution is an emulsion consisting of water, dissolved alkali, lubricating oils. The choice of an effective method or combination of treatment methods in a given production depends on the volume, type and composition of emulsion wastewater, the concentration of pollution and the required degree of treatment, for possible reuse of treated wastewater [2].

The classification of oil-emulsion wastewater treatment methods, based on a synthesis of domestic and foreign data depending on the initial oil content and their physical condition, is presented in the diagram below (Figure 1).

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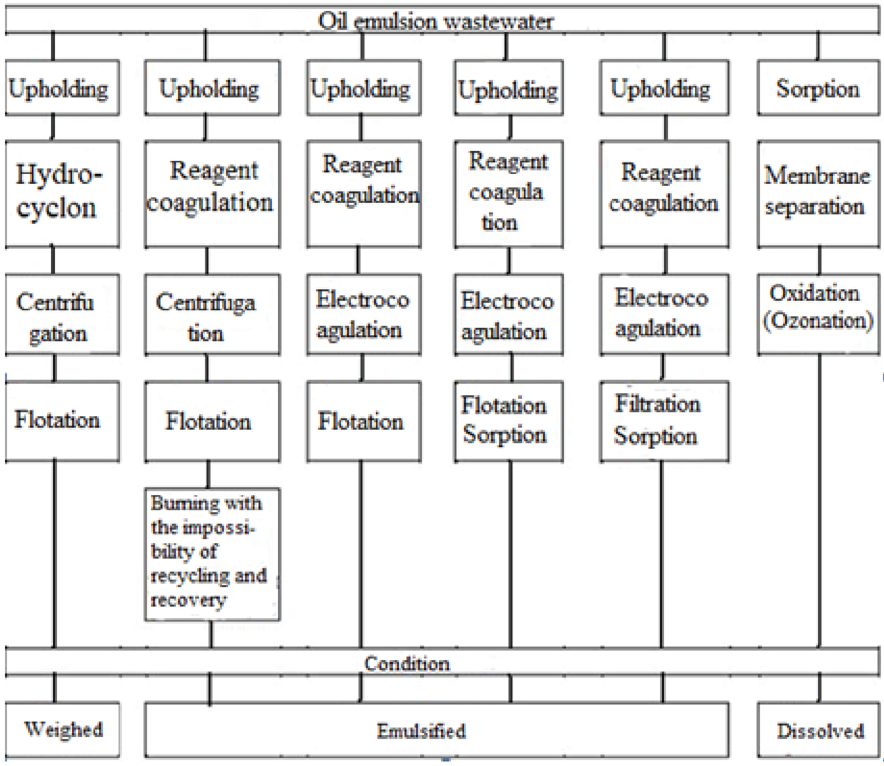

Figure 1: Classification of the main oil purification methods - emulsion wastewater.

The study of various methods was carried out on a sample of wastewater with a pH value of pH = 11 (alkaline medium), which was subjected to physicochemical, electrochemical, physical and thermal methods of exposure followed by mechanical filtration. Filtration of oil-emulsion wastewater was carried out on closed filters using hydroanthracite, quartz sand, crushed expanded clay, as well as purification using a ZeeWeed ultrafiltration hollow fiber membrane.

The physical method, based on gravity sedimentation and subsequent filtration, did not give positive results for the separation of water and oil fractions from the emulsion. The consistency of wastewater has remained almost unchanged.

Thermal and electrochemical methods were carried out in a sequential chain. This part is multioperational using sophisticated laboratory equipment and control systems. In the technological process for the experiment, an electrocoagulation process was carried out using a pulsed corona discharge. Under the influence of an electric current, an electrolytic decomposition reaction of aluminum occurred, but the sample did not change the characteristics described in the wastewater treatment by electrocoagulation to form a precipitate.

At a voltage of 12V on the electrodes, the steel electrode was covered with an oxide film, and the aluminum electrode decayed, forming a precipitate at the bottom of the flask. When mixing the mixture for uniform distribution and volumetric entry into the reaction of decayed aluminum, separation did not occur. At high alkalinity, aluminum-containing reagents are also not included in the reaction; therefore, it is necessary to acidify the treated solution, which leads to an increase in the cost of this technology.

During the heating procedure in a thermoreactor (Hach LT200), the aim was to break the water-oil bond and to destroy the suspension. It was assumed that the emulsion due to the heating of the solution will be divided into oil-water phases. The experiment did not give positive results. With an increase in heating above 70 degrees, oily deposits formed on the walls of the equipment and pipes, in connection with which the experiment in this direction was suspended due to the risk of damage to the process equipment.

The physicochemical method using a reagent purification method gave a positive result. As reagents used acid in marketable form. The sample was subjected to reagent treatment and was filtered on a Blue Ribbon filter with a pore size of 5 microns and a filter with bulk material hydroanthracite.

The best result was obtained by the ultrafiltration method for separation of water from the spent washing solution, which includes oil products. A positive fact is definitely a non-reagent processing method. As an ultrafiltration, a fiber tube membrane with a pore size of 0.04 μm was used.

When dosing citric acid with a ratio of 1:20 (5 ml / l) in the wastewater sample of the finned pipe cleaning system, the color of the solution changed from beige with a grayish tint to gray. The consistency of the solution has not changed. When filtering, sedimentary material was retained on the filter, and the filtered water became more transparent, and a white precipitate formed during settling. The turbidity of the filtered water was determined by a HACH 2100 Q turbidimeter and amounted to 18.6 NTU, while the turbidity value of the initial wastewater was more than 1500 NTU. The filtered solution is neutralized from pH = 11 to pH = 8.

When dosing hydrochloric acid with a ratio of 1:40 to a wastewater sample of a finned pipe cleaning system, the consistency and color of the solution changed, with further filtering, sediment material was retained on the filter, and the filtered water became more transparent than the original wastewater. The turbidity of the filtered water was determined by a HACH 2100 Q turbidimeter and amounted to 51.3 NTU, while the turbidity value of the initial wastewater was more than 1500 NTU. The filtered solution is neutralized from pH = 11 to pH = 8.5.

When dosing hydrochloric acid with a ratio of 1:20 into a wastewater sample of a finned pipe cleaning system, a color change occurred from beige with a grayish tint to a milky-white color of the solution. The consistency of the solution became thicker. During further filtration, sedimentary material was retained on the filter, and the filtered water became transparent compared to the initial wastewater and the previous experiment in a ratio of 1:40. The turbidity of the filtered water was determined by a HACH 2100 Q turbidimeter and amounted to 10.3 NTU, while the turbidity value of the initial wastewater was more than 1500 NTU. The filtered solution is neutralized from pH = 11 to pH = 6.

During the study, it was found that the most optimal is the clarification of wastewater of the finned pipe cleaning system using the physicochemical method, which implies the use of a reagent purification method using acids as reagents. As a result of reagent treatments, it was found that the best performance was achieved using hydrochloric acid in wastewater in a ratio of 1:20.

As a result of the research, a method was developed for the regeneration of spent washing solution in a finned pipe cleaning system using hydrochloric acid, filtering the precipitation products and returning purified water to the washing solution preparation unit (Figure 2).

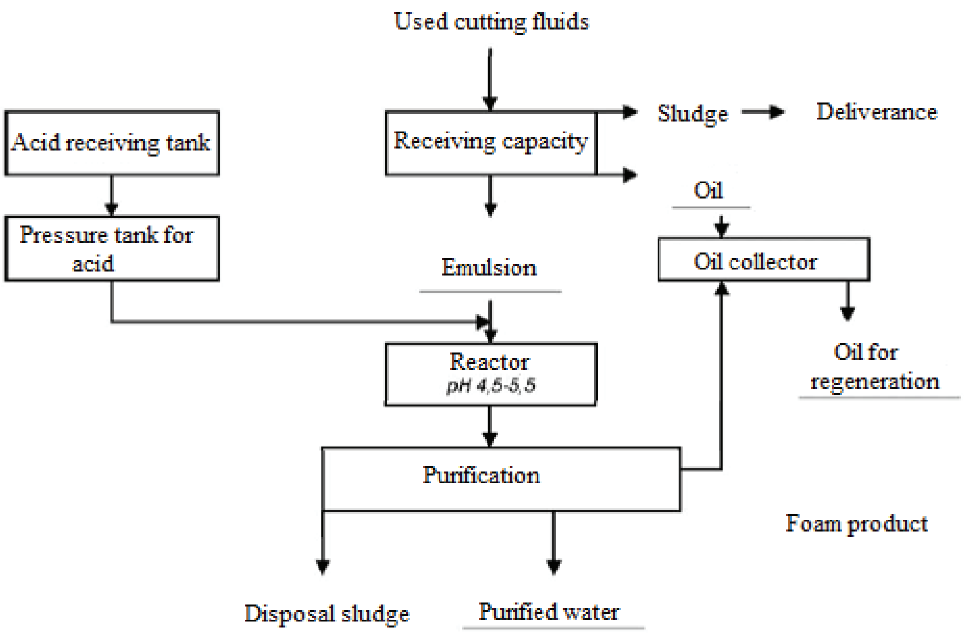

Figure 2: The technological scheme of the treatment of spent detergent solution.

During pipe washing, the waste water of the finned pipe cleaning system accumulates aluminum ions in the form of aluminates:

$$2Al + 2NaOH + 6H2O = 2Na[Al(OH)4] + 3H2$$

if the metal surface is already passivated, then the following reaction equation is observed:

$$Al(OH)\ 3 + NaOH = Na[Al(OH)4]$$

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The accumulation of aluminates gradually destabilizes the wastewater of the finned pipe cleaning system and renders it unusable with the subsequent disposal of the entire solution. In this regard, the main objective of the study is to reduce the volume of wastewater of the finned pipe cleaning system for disposal by separating the resulting emulsion into sediment and clarified water returned to the washing solution preparation system

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